N° 17,094 A.D. 1911

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COMPLETE SPECIFICATION.

Improvements in Friction Gearing.

I, LUDWIG MARIA DIETERICH, of No. 12, Oneida Avenue, in the City of Mount Vernon, County of Westchester, State of New York, United States of America, do hereby declare the nature of my said invention, and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention relates to friction gearing of the kind in which the normal pressures on the shaft are balanced, and comprising for example an inner member, a relatively-free eccentrically-disposed annular member, and intermediate members of which one serves as a wedging member to obtain the required pressure between the friction surfaces; the movement of said wedging not being primarily produced by a spring or other external force.

In previous constructions as Foster No. 24,669 A.D. 1899 the bearings of one or more of the intermediate members are fixed relatively to the inner member, and in other constructions as Jenkin No. 1913 A.D. 1883, in which all the members are relatively free, the wedging pressure is produced by a spring or a positive external force.

According to my invention all the members are relatively free and the wedging pressure is not primarily produced by a spring or other external force, but the wedging member moves wholly or principally under the influence of the torque reaction.

Figure 1 of the drawings represents an end elevation of one of the several forms in which the said invention may be embodied. Figure 2 is a diametric vertical section.

10 may be considered the driving shaft mounted in fixed bearings 11 and having keyed to it the primary roller 12 with its axis at 30. 13 is the other primary roller or driven element in the form of a ring externally provided with a belt-pulley 14, said element being supported by the intermediate rollers and having its floating axis at 31. The center 30 is somewhat eccentric to 31.

15 is a wedging roller intermediate between 12 and 13, its journals 16 being mounted in bearings 17 in radial guides 19 on a pair of arms 20, the latter being pivoted on the axis 30. The weight of parts 15 *etc.* serves to depress this roller into the tapering space between 12 and 13, but only for the purpose of producing the initial contact. Rotation of the roller 12 being in the direction of the arrow thereon, the roller 15 tends to be moved into this tapering space until all of the rollers are in full contact, whereupon the axis of roller 15 becomes fixed in relation to the driving and driven members, its motion becomes purely rotative, and the surface speed of the driven member becomes the same as that of the driving member. When 12 is rotated in a direction opposite to its arrow, the driving action ceases, and although a driving effect may still result if 15 is urged into the tapering space by a spring, a heavy weight or other external force, yet this effect would only be in proportion to the magnitude of the external force, and would not automatically vary with the resistance offered by the driven member. The relative direction of rotation is therefore an essential factor.

The wedging effect of 15 produces thrusts normal (that is, perpendicular) to

the contacting surfaces, in the directions 32—33, 34—35, and these thrusts are communicated to the floating annular roller 13. To balance these thrusts the additional intermediate rollers 21 and 22 are interposed between 12 and 13 at angles of substantially 120° from each other and from 15, their journals, 23, 24 having bearings 25, 26 mounted in radial guides 27, 28 on a fixed frame or spider 29. These balancing rollers, by virtue of their radially-floating axes, act as additional transmitters of power between 12 and 13, and the pressures on all six points of contact will be substantially equal. This is also an important factor, for even if the axis of roller 15 were free to adjust itself both radially and laterally, yet if the axes of the other intermediate rollers were not movable radially, there would be undue pressure upon their journals, and they would fail to fully act as power-transmitters. The lateral pressures on the bearings 25 are only the regular torque-resultant pressures, and those on the bearings 26 are but slightly in excess of such pressures.

It will be seen that 30 is the only fixed axis, although of course 31 might be fixed and 30 floating. It is also not always essential for 12 to be the driving and 13 the driven roller. If 12 is to drive in the reverse direction of rotation, roller 22 may be mounted on a pivoted arm similar to 20. If it is to drive in either direction at will, both of the rollers 15 and 22 may be mounted on swinging arms.

The rolling surfaces are shown as cylindrical and the intermediate rollers are flanged, but these are details, and the surfaces might be rounded to give point instead of line contacts. The number and disposition of the rollers may also be varied.

A third and very important factor lies in so choosing the angle between the surfaces of rollers 12 and 13, or other elements which may furnish an equivalent tapering space, and so choosing the shape of said space, that the angle shall not be so large as to cause the wedging member to slip toward the mouth of said space by reason of too little friction upon it, or so small as to produce normal pressures upon the rollers, exceeding the elastic limit of available materials, and furthermore that those normal pressures shall not be unstable, that is, tend to accumulate in greater ratio than the driven resistance.

In Figure 1 the angle between the tangent lines 36—37 and 38—39 represents the angle of the surfaces of 13 and 12 at their points of contact with the wedging roller 15, and I have discovered that this angle may be as great as twice the "friction angle" or "angle of repose" for sliding surfaces having the coefficient of friction of the materials composing these rollers. If the rollers are of steel, whose coefficient of friction is about fifteen *per cent.*, then the angle between 36—37 and 38—39 may be as great as 17°, which is twice the angle (8½°) whose tangent is .15 (approximately).

In practice I have actually employed an angle of about half the permitted maximum, or 8½°, without producing undue normal pressures at the contact points 32, 34. The permitted minimum limit of the angle is somewhat more indefinite than the maximum, depending as it does upon the strength of materials and the torque which is to be transmitted, but it should not be so small as to create permanent distortion or prevent the easy release of the wedging member by reversing the driving or advancing the driven roller.

It is evident that the axis of roller 15 will be in equilibrium when the resultant of the driving force of 12 acting along 32—39, and the equal resistance of 13 acting along 34—37 (which resultant tends to move the roller axis toward the apex of the angle) is equal to the resultant of the normal reactions along 32—33 and 34—35, tending to move said roller axis toward 40. By constructing the parallelograms of forces it will then appear that the normal pressure at 32 or 34 varies directly with the magnitude of the driven resistance, and by comparing the equation for this pressure in terms of the resistance and the function of the selected angle, with the equation for the driving pressure in terms of the coefficient of friction and the function of the "friction-angle", it can be shown

that the coefficient of friction is equal to the tangent of one-half the selected angle, as above stated. In other words, the maximum angle to be chosen is double the angle whose tangent equals the coefficient of friction of the contacting materials.

It follows from the above, that with a properly-chosen angle between 12 and 13, the rollers will never slip when 12 drives in the direction of its arrow, for with any increase of the driven resistance, the normal pressure, and hence the friction at all six points of contact, increases in the same ratio, by reason of the tendency of roller 15 to move farther into the tapering space.

Stability of pressures is attained by having this space favorably shaped and the wedging roller 15 located at a point sufficiently remote from its narrowest part. In the mechanism shown, quite a wide choice of speed ratios is obtainable by varying the relative sizes and positions of the rollers in the light of the foregoing explanation.

The scope of my invention is not confined to an unchanging speed ratio, but variable-speed gearings on this plan would constitute additional inventions.

Having now particularly described and ascertained the nature of my said invention, and in what manner the same is to be performed, I declare that what I claim is:—

1. In friction gearing of the kind in which the normal pressures on the shaft are balanced and comprising an inner member, a relatively free eccentrically-disposed annular member, and intermediate members one of which serves as a wedging member to obtain the required pressure between the roller surfaces, the movement of said wedging member when under load not being produced by a spring or other external force; mounting the intermediate members in radially-movable bearings whereby the several said members automatically adjust themselves relatively in a radial direction.

2. Roller gearing according to Claim 1, wherein the several rollers are mutually balanced by and within an annular roller, so arranging the rollers that they contact with the wedging roller at an angle not exceeding double the friction angle for the materials composing the rolling surfaces.

Dated this 19th. day of June, 1912.

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(1 SHEET)

Fig. 1

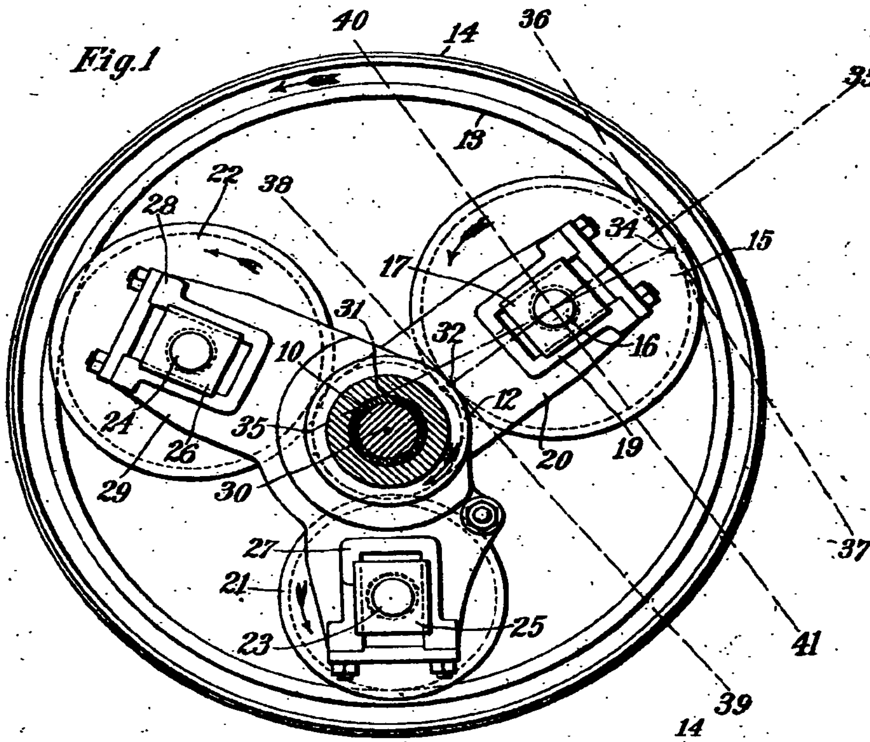
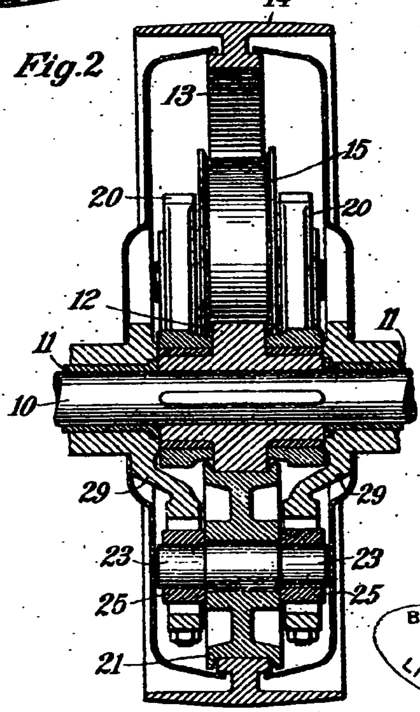


Fig. 2



[This Drawing is a reproduction of the Original on a reduced scale.]

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